COMPASS DEVIATION CARD

MAGNETIC COURSE FROM CHART ON OUTER ROSE

COURSE TO STEER BY COMPASS ON INNER ROSE

YACHT _____ OWNER _____

PORT _____ DATE _____

Aqua Meter®

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AQUA METER®

PRESTIGE CLASS COMPASSES

OWNER'S HANDBOOK

$1.50

GALAXY*

SATURN*

GEMINI*

About your new
Aqua Meter®
Prestige Class
Compass.

You are now a member of the fast growing fraternity of boat owners who have made Aqua Meter "Prestige Class" compasses their primary navigational tools. Galaxy, Gemini and Saturn compasses are superior instruments. Aqua Meter makes them in 20 different models. Every one is as accurate and reliable as more than twenty years of experience, expert craftsmanship and our trust up-to-date testing and designing can make it. You could not have purchased a finer marine compass.

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AQUA METER®
PRESTIGE CLASS COMPASSES
OWNER'S HANDBOOK

CAUTION: Because of Deviation normally present on most boats, any marine compass must be properly installed and compensated prior to use. See pages 8 thru 21.

Contents

Construction of "Prestige Class" compasses

1. Aqua Meter's "Prestige Class" compasses all have a full internal gimbal system with spherical fluid chambers.

2. All are basically similar in design. Their principal difference is the type of card and apparent diameter, which include 3¾ inches, 4½ inches and 5½ inches.

3. All offer superb optically clear domes for dependable, precise readings.

4. Compass cards are shaped to provide the best magnification and clarity, even at extreme viewing angles. They are calibrated in 5° marks with numerals every 30°. Large, easy-to-read N, S, E and W cardinal markings are provided.

5. True spherical dome assembly gives maximum card stability and minimum turbulence within the fluid chamber. Dampening fluid eliminates wild fluctuations due to boat motion. All are built for "high speed" operation. Sapphire jewels are used in all flat card models, and front reading models use a patented no-spin pivot system. Internally-gimbaled ultra-lightweight card, magnet and counterbalance systems provide maximum stability in pitch and roll. The dome and stabilizing optically clear mineral oil are both treated for protection against the damaging effects of ultra-violet rays in sunlight.

6. Galaxy and Gemini Series models feature bolted and gasket sealed construction. Saturn models are ultra-sonically sealed. All are field serviced by professional compass technicians in most areas, or may be returned to the factory.

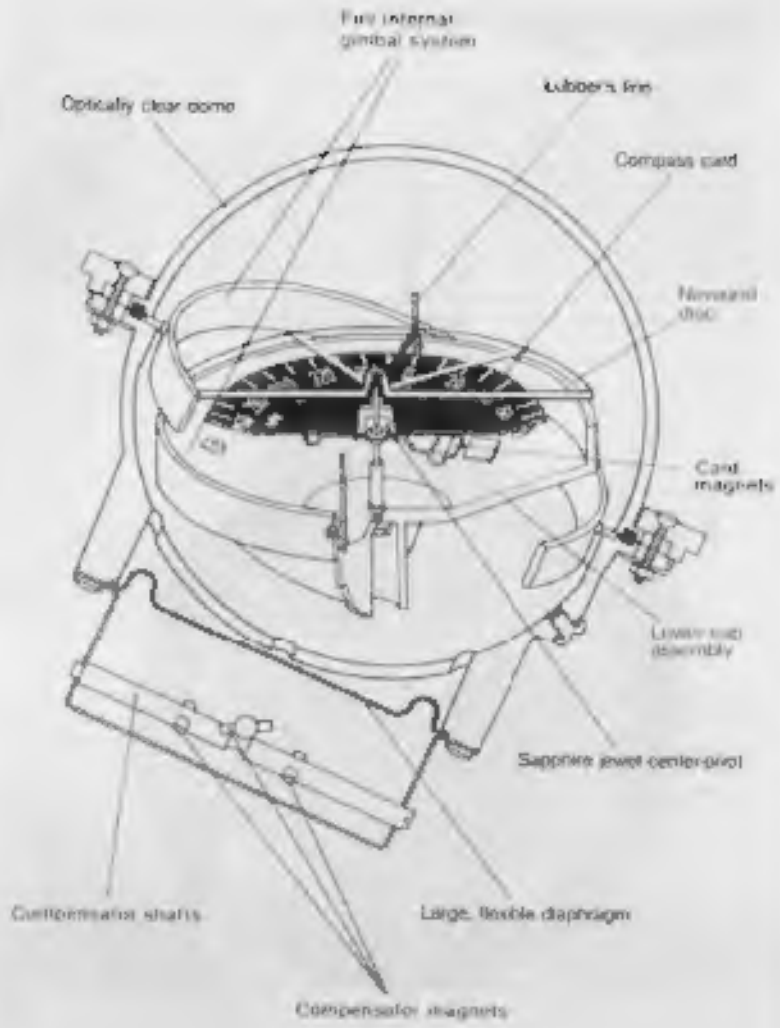
7. A large, specially formulated, flexible diaphragm maintains proper fluid pressure in the dome to prevent the formation of air bubbles.

8. Internal cross-bar compensating system below the compass sphere utilizes four specially matched magnets. Neutral pattern is virtually flat. In Galaxy compasses, a module that contains internal compensating magnets can be removed if deck magnets are preferred.

9. Internal compensators are hidden or recessed to prevent accidental movement or tampering after the compass has been adjusted.

10. In addition to the regular forward lubber's line, Galaxy, Gemini and all Saturn flat card models are equipped with an aft line for sightings and quick reciprocal course reference. Galaxy models also have 90° beam lines. All models, including front reading Saturn types, have two lines at 45° from the course line for fast, accurate bearings for sailboat tacking reference, and for reference at other than the usual helm position.

11. All Saturn and Gemini bulkhead models are illuminated for night use with easily replaced standard red bulb. Galaxy and Gemini (other than bulkhead) models have low-level red-filtered 50,000 hour lights just above the compass card for soft, glare-free night viewing. These lamp and filter assemblies should never need replacing. However, they are available from compass repair stations and from Aqua Meter's Customer Service Department.



Aqua Meter's patented NavaGrid® system

The NavaGrid system, exclusive with Aqua Meter, is the most innovative advance in compass design in years. It floats both the course line and 45° bearing lines over the compass card. A course may be steered from either side of the helm by taking advantage of the 45° grid lines. Since the gimbaled fixed course line is superimposed directly over the free-to-rotate compass card, following a heading is made much easier, especially from above the compass or at extreme viewing angles. The helmsman becomes instantly oriented as soon as he glances down at the compass. The taking of bearings by the helmsman or crew is much easier with NavaGrid than with any system. NavaGrid also makes tracking wind shifts faster and easier for racing sailors and for recognizing slight changes in the pointing of their boats.

For power or sail, NavaGrid is the ultimate refinement in compass design.

NavaGrid® system as seen from directly above, on a compass course of 235°

History of compasses

The question of who invented the first compass will undoubtedly never be resolved. We do know that man's first awareness of magnetism came centuries before Christ at a place called Magnesia, in Asia Minor. Iron ore found there had the strange ability of attracting other bits of iron, and was named magnetite after its place of origin. This type of ore was the original permanent magnet, and later was more commonly called "lodestone".

Discovery of the magnetic properties of lodestones brought to navigators the new concept of using what we now know as North as a reference point without depending on stars. Lodestones always seemed to point northerly. An early compass was simply a circular card stuck to a sliver of the ore, and rigged to swing in a horizontal plane on a central pivot.

In 203 BC, Hannibal set sail from Carthage with his pilot Pisonus, and what many historians believe was the earliest useful form of a magnetic compass to be recorded. Certainly the Chinese used a device for indicating north well over a thousand years ago. They floated a piece of cork in a bowl of water, and placed a piece of lodestone on the cork. Slowly, the lodestone oriented itself in an approximate north-south direction and maintained that direction no matter how the bowl was rotated. So we do know that the modern idea of floating a compass card to reduce friction and dampen fluctuations was an ancient discovery.

The first substantial description of a "pivoting floating compass with a lubber's line" was traced to the Norsemen in 1248, although their use of different forms of magnetic compass is believed to predate that by a thousand years.

However, it wasn't until about 400 years ago, in 1580, that the first determination of magnetic variation (described later) was made at Limehouse, England, by a series of magnetic observations. There is documentation that in 1801 Captain Matthew Flinders discovered a method for correcting deviation, although some marine historians also credit eleventh century Chinese and navigators of the Columbus era with its discovery.

In 1892, Lord Kelvin developed the far more accurate "Admiralty" type compass with a suspended pivot type card that basically is still used today. Other than invention of the gyro compass in 1911 by Elmer A. Sperry, and electronic and computer-controlled compasses in very recent years, research has been aimed at developing marine compasses that will take more abuse, last longer, read more easily and accurately, and cost less without sacrificing quality.

In this regard, several key design features of Aqua Meter's "Prestige Class" series represent advances in the state-of-the-art. Namely, unique over-sized expansion diaphragms eliminate the need to remove compasses for extended storage during severe winter layups. Ultra lightweight compass card assembly designs in combination with the special pivots and sapphire jewel configurations, for the first time eliminate the need for thick oil in compasses for high speed "performance" powerboats. An internal compensation mechanism that can be easily removed if dock magnet compensation is desired, and a patented high angle of visibility hood, have been exclusively designed for the Galaxy.

How your compass operates

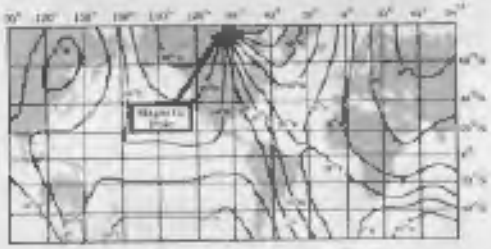
Back many eons ago when our planet was formed, a phenomenon occurred that has proven to be extremely important to all of us mariners. A molten mass of iron was trapped deep below the earth's surface and extends from near the North Pole to the South Pole. At least part of it is still molten today.

This mass of iron has made the earth into a giant magnet, with two poles at which the magnetic forces are concentrated. We refer to these as the "North Magnetic Pole" and the "South Magnetic Pole". Obviously, the magnets inside of the "Prestige Series" Aqua Meter compass that you purchased are designed to align the compass card with these two poles, and to "point" toward magnetic north.

Unfortunately for all generations of mariners past, present and future, the Magnetic North Pole is not at the true North Pole around which the earth rotates. It is not at the top of the earth. A United States government study published in 1970 (HO 1706) says that the Magnetic North Pole appears to be at about 78° North Latitude and 101° West Longitude, on the northwest coast of Bathurst Island in Canada's Arctic Region. This is about 860 miles south of the True North Pole. The Magnetic South Pole is at about 66° South Latitude and 139° East Longitude, on the coast of Wilkes Land in Antarctica . . . 1600 miles from the True South Pole. To make the situation seem even more difficult, the earth's magnetism is irregular as shown below. It has varied greatly throughout the ages, and at any given place it changes slightly each year because of movement of the molten iron.

All of this sounds pretty bleak . . . but it really isn't. A mariner can be an expert at lake and coastal navigation without ever knowing any of this. In fact, we are only mentioning it because it may help you understand why certain corrections are made when a compass is used for navigation.

It may now be easier to see that the meridians, or vertical lines on your charts, all meet exactly at the TRUE North and South Poles – not the Magnetic Poles. Almost all except ocean-crossing charts show a very small geographic area and for your convenience are drawn with a projection on which meridians are parallel. On a globe, you could easily draw an imaginary straight line from where you are right now to the True North Pole . . . and that line will point to TRUE North.



EARTH'S MAGNETIC VARIATION CHART

Variation

Your compass, however, is designed to point toward MAGNETIC North. The angle between straight lines from any location to TRUE North, and another to MAGNETIC North, is called the "Variation" for that location. Many generations ago this "local variation" was carefully calculated and (along with the very small "annual change") is conveniently shown on the "Compass Roses" of the navigational charts you use. This "Variation" is exactly the same for every vessel in the same geographic area, regardless of the directions they may be heading. Remember, the amount of "Variation" does vary from area to area.

Many skippers prefer to convert Magnetic courses and bearings to True, and this is particularly good practice for a mariner who plans to cross an ocean or to study celestial navigation. However, the great majority of skippers simply plot and sail "Magnetic". They do not use the outer "True" on compass roses, such as illustrated by the compass rose on this page. While not at all difficult to learn, the technique for converting "True" to "Magnetic" to "Compass" readings is best covered in a basic course, such as those given to the public by the United States Power Squadrons and the U.S. Coast Guard Auxiliary.

Deviation

It seems like a classic example of workmen unjustly blaming their tools, but mariners worldwide refer to "correcting compass error". The truth is that any high quality marine compass that is in good operating condition does not err. It indiscriminately reacts to all the magnetic influences around it . . . and these are what cause "error".

We discussed "Variation", and how that error is predictable. The compass card may actually respond more strongly to a spurious field than to the earth's magnetism. For an unbelievably astounding example of this, put even a small portable radio next to your compass and watch how violently the compass card reacts to the permanent magnet in the speaker – whether or not the radio is turned on. Try a steel beer can, a small screw driver, turn your ship's wheel (some are magnetic). If a cabinet or the galley is below your compass have someone move the cans and pots while you watch for compass card movement. On some sailboats and powerboats, turning on a 12 VDC electrical circuit near the compass can introduce an error; usually this can be solved by twisting the pair of electrical wires.

These are typical of the common causes of compass error called "Deviation" – which are unique to a particular boat with the gear aboard located in given places. Some well spent time in the future can help assure that new causes of error aren't introduced.

What about your big cast iron engine and other causes of "Deviation" that you can't eliminate? Other than trading for a boat with no engine and little gear, you are stuck and have to face the problem. Later in this owner's handbook, after we carefully cover the all-important subject of compass installation, we will discuss many of the ways to correct for Deviation on your boat.

Installing your new compass

Choosing the right location

If you intend to use your compass for point to point navigation, there is only one proper place for it to be installed – in a direct line forward of the helm station. It should also be close enough to the helmsman to be easily read and in a position slightly lower than the helmsman's line of sight to the horizon. With the compass in this location, it is most convenient to shift your eyes from the water to the compass and back again. If you had to look to

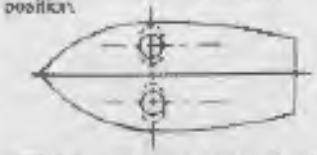
either side to view the compass and then look forward to check for water hazards, you would find it quite inconvenient. The exact placement of the compass must, by necessity, vary from boat to boat because of differences in design and in magnetic influences nearby. Sometimes it may be necessary to shift the compass from the most ideal location to a point of compromise because of visual interferences or adjustment problems.

If your need for a compass is for occasional use only, and not for very much long-range cruising, you might select a spot on the boat's dashboard or on the gunwale.

We suggest temporarily putting the compass in position for a Deviation check. This could also apply in selecting the most convenient location for viewing. It goes without saying that the place selected for permanent mounting of the compass should be a spot where it can be easily read by the helmsman.

Also, regardless of its location on your boat, your compass must be aligned exactly parallel to the fore and aft center line of your boat. (To repeat because this is essential to understand: parallel to the center line, or on the center line if that happens to be where you want to mount your compass.)

Establishing this line parallel to your boat's center line is quite simple, but it almost always takes a little more patience and time than the skipper anticipates. Find the center of the transom using a metal measuring tape, and accurately mark that center on a piece of masking tape (so as not to permanently mark the boat). This is usually easy. Next you need a second center point at some convenient location forward of the compass position.



With help from some additional point of items, stretch a string tightly between the two center points. Accurately measure out (athwartship) to the location you selected for your compass, and after marking off this distance at your transom and forward line, move the string to this new pair of points. If the string is higher than the area where the compass base will be, use a plumb bob to transfer the line. Of course the boat must be on an even keel if a plumb bob is used. Once you have checked to make sure that you accurately established your compass mounting line parallel to the boat's center line you might just want to permanently scratch or mark a short line for future reference. Obviously, you will install your compass so the "lubber's line" (fore-and-aft line on your compass or its NavaGrid) is exactly lined up with it. Many Aqua Meter compasses have small alignment marks (forward and aft) where the

housing touches the mounting surface to aid in positioning on the scratch marks.

This alignment is extremely important, because an improperly aligned compass can never be properly adjusted for deviation, and will have a constant error (in addition to Deviation) no matter what direction your boat is pointed.

If you suspect that there may be magnetic influences near the compass position selected, such as radio speakers, steel cored steering wheels, wiring, etc., it would be well to place the compass temporarily in the position selected and check for Deviation as you swing the boat. With the internal compass compensators neutralized, you should not have a Deviation of more than 15 degrees in any one heading in the compass location selected. Deviation greater than this will be almost impossible to correct, making it necessary to either change the compass location or move the equipment, wiring, etc., causing the problem, or use a

As received, the compass compensators should be in the neutralized position as shown. The screwdriver slots should be horizontal and the small notches on both compensator shafts should be positioned toward the bottom of the compass housing.

Compass Deviation Card (See page 19)

A compass with a flat card should be installed with the lubber's line farthest from the helmsman, forward of the center line of the compass, whereas a Saturn front reading compass should have the lubber's line closest to the helmsman or aft of the center line of the compass.

When the compass is removed from the boat for any reason, it is important to return it to its original position when reinstalling. This is particularly true of compasses which have been adjusted for Deviation using the built-in compensators.

When installing the light wiring to the compass or, for that matter, any wiring near the compass, twist the wires to preclude any possibility of influencing the compass by the magnetic field set up by parallel wires carrying DC current. In direct-current wiring, one lead carries the current in one direction, while the other lead carries it in the opposite direction. By twisting the wires, the current flow is changed from side to side, thereby largely neutralizing any polarizing effect on the compass.

Mounting your compass

Even though your compass has a built-in gimbal system for leveling, the compass should be mounted on a surface approximately level in relation to the water's surface both fore and aft and athwartships. Depending on the model, a shim block or some other method should be used to make the surface approximately level. A bulkhead mount model must be

mounted so its mounting surfaces are exactly at right angle to the fore-&-aft centerline. Fortunately, most sailboats have bulkheads designed this way, so no side-shimming is required. Vertical shimming is required if the bulkhead is sloped more than 15 degrees.

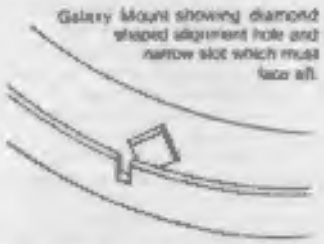
Important: The slotted compensator shaft and labeled "East/West" *must face aft*, and the "North/South" slotted end must face toward the *starboard* side of the boat.

Flush Mount

	Mounting hole size
Galaxy	5 9/16" diam. (use Mount Ring as a template)
Gemini	5" diam.
Saturn	3 3/4" diam.

Flush mount models are designed for mounting on the deck, thwart or other surface convenient to the helmsman. Before cutting the hole, be sure that it is an area free from structural members that might be weakened, and *not near highly magnetic influences.*

Galaxy: Separate the unique Automatic Alignment Mount Ring from the base of the Galaxy compass, by removing the four retaining screws. You can use the inside ring of the Mount Ring as a template for the hole that needs to be cut. Notice the diamond shaped fore-&-aft holes in the Mount Ring. Position the Mount Ring so that your drawn alignment line passes through the center of the diamonds, and mark near the center of the two elongated holes for drilling screw holes. Drill the two holes. Attach the sealing gasket provided to the bottom



of the ring. Secure the Mount Ring *making sure the narrow compass alignment slot in the top edge is facing AFT.* When accurately aligned, insert two additional mounting screws in the diamond shaped holes. Attach the Galaxy compass and reinstall the four retaining screws. (It usually is difficult to adjust the internal magnets of an installed flush mount compass. However, with Galaxy's unique Mount Ring, the compass can be removed for each adjustment with absolute assurance that alignment cannot change.)

Gemini and Saturn: Thin protruding fore-&-aft alignment lines are molded into the bezel ring; they may be a little difficult to find by eye, but are easy to locate by running a finger tip around the bezel. After cutting the mounting hole, insert your compass, align it carefully, and secure it with *only one screw.* Adjust the alignment, if necessary, and insert the other three mounting screws.

Bulkhead Mount

	Mounting Hole Size
Gemini	5 1/2" diam.
Saturn	4 1/4" diam.

Gemini and Saturn bulkhead models are designed to be mounted on bulkheads up to 25° from vertical, that are at right angle (athwartship) to the boat's centerline. Flat card models should be located below eye level when viewed from the helm position. Cut a hole in the bulkhead to receive the rear of the compass. Make sure the area you select is free of excessive magnetic influence, structural members, and obstructions that might interfere with recessing the compass. Also, provide space for routing the light wiring.

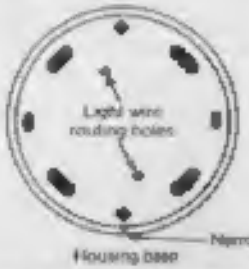
To install the bulkhead mount bezel gasket, peel about 6" of paper away from it. Starting with the screw boss on the left side of the compensator opening (when viewed from the rear), align the first notch in the gasket on the boss. Peeling more paper as required, and being careful not to stretch the gasket, continue around the bezel, putting the edge of the gasket against the rim of the bezel. Press lightly to tack it in place. When the alignment is satisfactory and the gasket is completely in place, press firmly all around for the best possible adhesion.

Durable plastic compass body covers are available for bulkhead models to protect and cover the portion of the compass that protrudes through the bulkhead into the cabin.

Binnacle Mount

Galaxy and Gemini flangeless binnacle mount models must be separated from their lower housing before mounting. (Remove the small screws in the sides of the upper ring of your Galaxy, or the four large head screws on the top surface of your Gemini's upper ring.)

The narrow alignment slot in the top of the housing must face aft. Center the housing on the alignment line ensuring the two diamond shaped locating holes (see diagram below). There are three light wire routing holes in the compass



housing. Two holes are located in the bottom and one in the vertical forward wall section of the housing which has a hole plug inserted. If routing the light wire through the vertical forward wall is a preferred remove hole plug and insert narrow grooved rubber grommet supplied with compass. If routing the light wire through the bottom, spot the preferred routing hole and drill a ½" diameter clearance hole through the mounting surface. Insert the narrow grooved rubber grommet into the preferred light wire hole and realign housing on alignment line. Place two of the screws provided in the center of the small elongated holes located right and left of the housing base. this will enable you to rotate the housing in the elongated holes to correct any minor misalignment.

When you are certain the compass is accurately aligned with the hull, insert the

either two screws into the two locating holes. If you are at all in doubt about alignment, install the compass and compensate it before inserting the last two screws. As already mentioned, a constant error in one direction indicates that the compass is misaligned by the amount of the constant error.

Slip light wire through grommet hole and re-install the compass. Caution: care should be taken not to overtighten the four small screws that secure the compass ring to the housing.

The four additional ¼" elongated holes in the lower housing are provided for pedestal steerers. These holes align with the threaded mounting holes in most of the popular pedestals such as the Edson, Yacht Specialities and Onkel. Nonmagnetic screws (usually furnished by the pedestal manufacturer) should be used to secure the lower housing to the pedestal. An adaptor plate is provided with Gemini binnacle models to assure coverage of the steerer top. When using the adapter plate, align holes in the adapter plate and housing base and insert wide grooved grommet (furnished) into selected light wire routing hole. This will attach the adapter plate to the binnacle allowing for an easier installation. If the pedestal is equipped with a pedestal guard top support plate, the adapter plate is not needed.

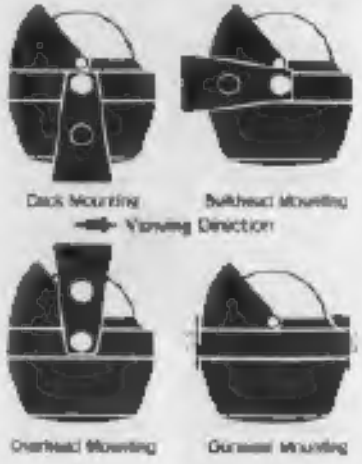
Saturn binnacle models are surface mounted. A pair of raised fore-&-aft locating marks on the edge of the mounting flange are used for alignment. The aft locating mark is immediately below the raised letters "EAW" which identify that compensating slot. Make sure your compass is reasonably level both fore-&-aft and athwartships. If the deck slopes off where you intend to mount the compass, a shim block should be made to provide a level surface.

After you have prepared the mounting location, mount the compass using the four screws provided. We suggest fastening it with only one screw at first so that you can check its alignment. Then carefully center and drill or punch the necessary pilot holes and screw in the other three screws. Refer to the fore-&-aft alignment marks on the compass flange to help you get the proper alignment.

Bracket Mount

Saturn bracket mount models are designed for mounting in almost any convenient location - overhead, on deck or bulkhead. Saturn bracket mount compasses also can be mounted on a gunwale. When you take your Saturn out of its shipping container, it will have its bracket installed at 90° from the lubber's line. If you want to mount it on your gunwale, remove the two screws 90° from the bracket and rotate it to the new position. A mounting shim will be required if the gunwale is not exactly parallel to the boat's keel line.)

Remove the bracket from the compass by unscrewing the two thumb screws (be sure you don't lose the rubber washers that belong between the bracket and the compass body). Orient the front of the bracket so it is at a right angle to the fore-&-aft alignment line that was drawn as described on page 8. Using one screw, secure the bracket in place and



recheck the alignment before inserting the other screws. Remount the compass.

For maximum accuracy, position the compass using the two large thumb screws so that the housing is in a vertical position. To compensate Gemini compasses, remove the screw on the bottom, and slide off the lower housing so as to get at the compensator shaft ends. The Saturn bracket has an opening in each side to let you adjust it without tipping the compass.

Care of the compass

Your Aqua Meter compass has a fluid-filled Lexan® (Galaxy and Gemini) or acrylic (Saturn) plastic dome. These types of plastic provide high light-transmission and they have excellent optical properties. While they may have the appearance of glass, they are softer and more readily scratched. Therefore, care should be taken to keep the compass dome from being abraded. Never use abrasive silicone or alcoholic cleaners. If the compass has become encrusted with salt from salt water spray, the crust should be flushed off with fresh water before any attempt is made to rub or polish the dome.

We recommend a mild soap and water for cleaning the dome and suggest waxing, using an automotive wax such as Simoniz. Be careful to avoid waxes that contain abrasive cleaners or [illegible]

When storing your boat, if your compass is removed, be sure that the compass is replaced in the same direction. If you suspect the compensators may have been disturbed, it would be well to check for changes in compensation. In any event, as pointed out earlier, you should, from time to time, check the accuracy of the compass to be sure that it has not changed due to relocation of equipment on the boat or other factors.

Lamp replacement

Galaxy: Two special bulbs with red filter assemblies designed to last for 50,000 hours are contained in the unique Galaxy low level night lighting system. It therefore is doubtful that any will need to be replaced. However, the bulbs are available from compass repair stations or direct from Aqua Meter Customer Service. To replace a bulb, simply remove the hood and light cover. Bulbs are supplied with electrical leads attached that need to be soldered or crimped in place.

Gemini: All Gemini bulkhead mount compasses are supplied with a standard No. 53 miniature bayonet for 12 volt electrical systems. Use a coin in the slot provided to pry off the light cover, and snap out the light kit. On all other Gemini models follow same procedure outlined above for the Galaxy series; however, the Gemini uses a light assembly part #183-2.

Saturn: All Saturn compasses are supplied with a standard No. 53 miniature bayonet bulb for 12 volt electrical systems. For a 6 volt system, replace it with a No. 51 bulb. A 24 volt system requires a No. 330 bulb. On bulkhead models use a coin in the slot provided to pry off the light cover, and snap out the light kit. On all other models, remove the two hood pivot screws and two rubber washers and snap out the light socket. When reassembling make sure the rubber washers are positioned between the hood and the compass housing.

CAUTION: Use polysulfide base materials for bedding compasses. Silicone base compounds may attack the dome and case materials and should not be used.

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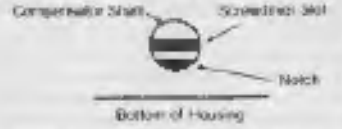
Compass correction

There are a great many approaches to the problem of reducing or eliminating "Deviation", or "correcting" your compass. The average boatsman will be more than satisfied with the job he can do himself in an hour or two in calm, flat water, with no special tools. Others will prefer to use a sun compass, pelorus or surveyor's transit plus some extra pairs of hands to do a more accurate job. Then of course many will prefer to arrange for the services of a qualified professional compass adjuster who has the special tools and experience to fairly quickly compensate your compass and make a "Deviation Card". (See back cover.)

Just a three degree compass error means your boat will be one mile off course for every twenty miles run. So the distances you plan to cruise are a big factor in deciding the care you should take, and the frequency of rechecking compensation.

Your new Aqua Meter "Prestige Class" compass has compensators built into the lower assembly. These small magnets were adjusted to "neutral" at the Aqua Meter factory, but during the compensating process they will be rotated by means of the slotted shaft ends to cancel out magnetic deviation.



A small non-magnetic screwdriver was supplied with your compass for this purpose. (Keep it for future use.) Deck magnets can also be used for compensating. If deck magnets are used, the internal compensating magnets are either removed or set at the "neutral" positions.

Were we in an automobile and wished to adjust our compass, it would be a simple matter to find streets going approximately North-South and East-West. When compensating compasses on airplanes, usually a compass rose painted on the airstrip is available to accomplish the job. On the water there aren't any streets, nor are there compass roses painted on the water to assist us.

Of course, your compass needs to be carefully located and installed ahead of time. With your boat standing still, turn on and off all electrical circuits within two feet of your compass to make sure nothing makes the card move. If any circuit does move the card, twisting the pair of wires will usually cure the problem. Make sure to move (permanently) away anything that contains a magnet . . . like a radio speaker . . . and anything such as tools and beer cans that are "magnetic". The rule of thumb is two feet away. But the best guide is to move magnetic objects far enough away to not cause card movement – plus an additional six inches if possible.

Pick a day when you can relax and enjoy learning how to compensate your compass. Especially for a "first timer", the water should be calm and currents should be slack or slight. Bring some helpers, but not a crowd that is anxious to get the job over with.

There are a couple of other guidelines to remember.

(a) Particularly on a powerboat, first compensate for East-West Deviation. This is most likely to be greater than North-South, because the iron mass of your engine causes greater E-W Deviation.

(b) East, West, North and South are called "cardinal" compass points, and you actually will work to eliminate deviation in these directions. By so doing, it is most likely that you will drastically reduce or eliminate deviation at points midway between the cardinal points . . . 045°, 135°, 225° and 315° which for obvious reasons are called "inter-cardinal points". Even if you hire a top professional to compensate your compass, you may still have errors as great as perhaps several degrees in some inter-cardinal areas. It most likely isn't the adjuster's fault but rather something unique to your boat. A Deviation Card should be constructed, and we've included a simple card and instructions for that purpose. This subject will be covered in detail on page 20 and 21.

(1) Quickest and easiest . . . also a great periodic check.

This technique is so quick and easy that knowledgeable editors from many of the leading boating publications have travelled many miles to see it done on one of Aqua Meter's test boats. Each time they said, "You are right. It works!" . . . and they wrote about it.

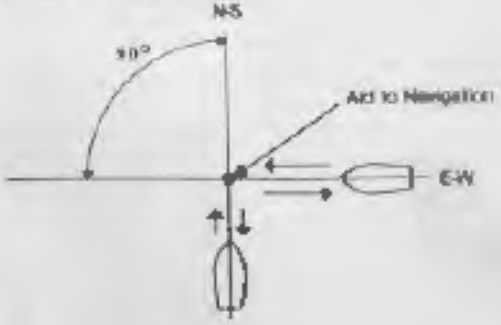
On a calm day with fairly slack water, run your boat close to an aid to navigation . . . preferably a fixed rather than floating aid . . . that is well clear of heavy traffic, and where you can run in a straight line either East or West from the aid, and also either North or South from the aid. Plan to run at a moderate speed at which you can comfortably steer a straight line while carefully watching your compass. (Other members of your crew will need to watch for other boats and make sure you are on a safe course.)

With the aid fairly well centered on your transom, run away from it either East or West for about a half mile to a mile – carefully steering either 090° or 270° on your compass. Slow down and turn tightly so your bow points exactly at the center of the aid. Steer precisely toward the aid, back through your boat's wake, and again run at a moderate speed – ignoring your compass reading, except to note any error.

If there is no East/West Deviation, your compass will read 270° or 090° on this return leg. Most likely it will read a few degrees (or as much as 10 to 15 degrees) high or low. A crew member should carefully read this . . . while you stick to running straight toward the aid. Whatever the error . . . say it reads 094° rather than 090° so the deviation is 4° . . . have a crew member remove HALF the error by turning the E-W compensating screw slightly until the compass heading changes 2°. (In the example given, it should read 092°.)

Run back close to the aid and repeat the procedure in the North-South direction, again removing HALF the Deviation. Then repeat East/West and North-South both a second time to further refine your compensation.

That's the end of the procedure . . . except that you may well want to make a "Deviation Card" as will be explained on pages 20 and 21.

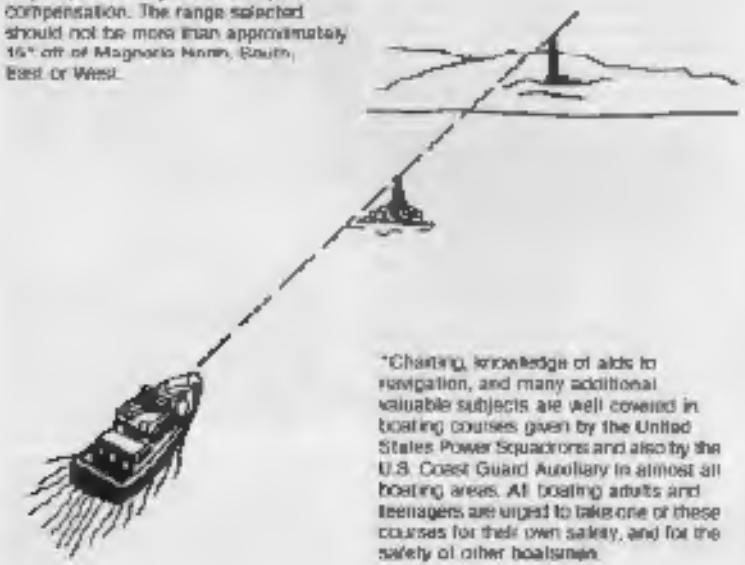


(2) Using "Ranges". Still no special tools, and very popular.

Aids to navigation called "Ranges" are most common on rivers and other areas where it is essential that commercial traffic stay in the deeper water of a channel. Most commonly they are lights on pairs of towers, from very large to fairly small, but always with the closer one lower than the further one. A vessel approaching the area "guarded" by the range will set a course toward the closer tower or light, carefully keeping the second one directly behind it. There's no need to steer by compass, and the helmsman knows he is on course. Naturally, these ranges are clearly shown on government navigational charts of the area, and if only talkes basic charting techniques* to find out the magnetic direction of the range. Clearly, if any of these ranges in your boating area are set close to East-West or North-South, it is delightfully easy to adjust your compass while a crew member runs your boat directly toward or away from it. This also is an excellent way to periodically check compass compensation. The range selected should not be more than approximately 15° off of Magnetic North, South, East or West.

More commonly, there are fixed "aids" on shore, such as radio towers or tall buildings, that are shown on your local charts. There also are fixed aids on the water, such as those that guard exposed rocks. Chances are you will find pairs of these on your charts that are close to E-W and N-S that you can use as your own ranges for compensation purposes.

Caution: especially in tidal waters, where the water rises and falls significantly each day, floating aids are not good for compass compensation. Like a boat mooring, they do not stay in one exact place, but tend to drift as far as their holding chain allows. You cannot know their precise location at any time, and precision is essential for compass compensation.



*Charting, knowledge of aids to navigation, and many additional valuable subjects are well covered in boating courses given by the United States Power Squadrons and also by the U.S. Coast Guard Auxiliary in almost all boating areas. All boating adults and teenagers are urged to take one of these courses for their own safety, and for the safety of other boatsmen.

(3) One last technique with no special tools . . . but some reservations.

This one relies on a friend and boat owner who you know without question recently had his compass accurately compensated, and has (and uses) an accurate "Deviation Card", or knows that Deviation is so slight that it is not required. Very simply, using radio or hand signals for communications you ask him to accurately steer exactly East or West at a speed that will allow your boat to comfortably follow on the same course, so you can adjust your compass to match his course. Then you repeat the procedure so that you can adjust all four "cardinal" directions (north, east, south and west), and perhaps even repeat a second time to make sure your compass now agrees with the compass on your friend's boat. Finally, ask your friend to steer 045°, 135°, 225° and 315° so you can check your compass but not adjust it at these inter-cardinal headings. If your compass agrees within plus-or-minus a couple of degrees you have done about as fine a job as is possible with this technique. (If not, follow your friend's boat on a number of other courses, perhaps changing 15° each time, and be sure to mark the Deviation Card on the back cover of this handbook.)

The "reservations" are obvious. You are relying on your friend's compass being accurately adjusted, and both boats being steered just as accurately. However, carefully using this technique is vastly more safe than starting on a cruise with a shiny new compass that has not been adjusted (compensated). It is extremely good practice to cruise with several other boats, so that each can be available to help another. Unfortunately, all too often a primary reason for joining other boats on a cruise is because the skipper who follows along has no confidence in his compass. Boats can and do get separated in fog and storms, and if a skipper distrusts his compass in clear, calm weather, he or she is very likely to panic at the critical time when a plotted course must be accurately followed by compass no matter how turned around it may seem. Never substitute "following" for "compensating".

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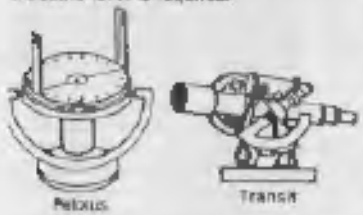
(4) Two or more compasses installed on a boat.

This is going to sound so obvious that you may wonder why we wasted space on the page. However, it is so obvious that over the years we have talked with numerous experienced skippers who never thought about it. Very simply, if you have more than one compass installed on your boat (for example, bridge and lower station on a powerboat, or pedestal and bulkhead or deck mounted on a sailboat), devote a great deal of effort to accurately compensating one of the compasses. Then have a qualified crew member steer courses using this "master" (also called "Standard") compass, while you adjust the other compasses to match the readings. Deviation Cards probably will be different for each compass location.

A professional compass compensator will probably use one of the following techniques. For best results calm, flat water is needed.

(5) Bearings on a distant object – using a pelorus or transit.

This technique can be extremely accurate, and both compensation and preparing a Deviation Card can be done relatively quickly. A gimbaled pelorus, or far better, a surveyor's transit with a bubble level is required.



Pelorus Transit

By eye, pick out a conspicuous landmark such as a stack or a lighthouse that is at least six miles away. (At this distance any minor movement of your boat in turning 360° will not detract from accuracy.) Surprisingly, you do not need to calculate the magnetic bearing from your boat to the landmark; you don't even need to refer to a chart.

The object is for a helmsman to only change course so as to keep the compass lubber's line on 090° or 270°, while a second person turns the pelorus or transit so it exactly points at the landmark. The pelorus or transit is then rotated (and leveled) exactly 180°, and the helmsman is asked to very slowly turn the boat until told that the landmark is again lined up in the sights. At that instant the helmsman is asked to read the compass. If the difference in reading is not exactly 180°, the difference is noted, and with the boat held in that direction while one-half the error is adjusted out. This technique is repeated at 000° or 180°, and again in the E-W and N-S directions.

In actual practice, the helmsman will not be able to exactly hold 000° or other courses, but will call out readings while the pelorus or transit is set on the landmark. Then when the boat is rotated exactly 180° as shown on the pelorus or transit, the observer will call "Mark" to tell the helmsman to read the compass. The helmsman might elect to turn the boat to the left and right of the "Mark" for additional readings, and of course a more accurate average compass reading. After N, E, S & W compensation is completed, it is most prudent for the observer to rotate the pelorus or sextant in 15° increments, and have the helmsman slowly rotate the boat so as to find deviation errors to mark on the Deviation Card.

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(6) Sun compass corrector

A professional quality "sun compass corrector" has a counter-clockwise reading 360° compass rose that can be rotated, with a thin, straight pin inserted in the exact center of it. A well weighted, two-axis gimbal system is essential to assure that the compass rose remains level, because the observer will need to accurately read sun shadows from the pin on the rose. This technique requires not only flat water, but enough sunshine to cast crisp shadows.

The earth rotates 360° in about 24 hours, so the sun appears to move across the sky at a rate of one degree every four minutes. This means that the helmsman and observer need to work reasonably fast for best accuracy, but with a little practice, there's plenty of time.

Without making waves that will rock the boat, the skipper will turn his boat until the compass reads either 090° or 270°. In actual practice, he or she will call out compass headings as East or West is approached, so the observer can rotate the corrector's rose to about the same readings. At exactly 090° or 270° by compass, the shadow must be set at exactly the same point on the sun corrector's rose. The skipper/observer team may want to repeat this to make sure the compass and shadow agree, because this is obviously essential for everything that will follow.

The skipper will then slowly rotate the boat, while the observer calls out readings on the rose, until the shadow is exactly 180° from the first reading. At exactly that point, the helmsman will observe the compass reading.

Professional Cerra Sun Compass Corrector

Obviously, it will read exactly 180° different from the initial compass reading if the compass happens to be correctly compensated in the East-West directions. Otherwise, the skipper will hold the heading shown by the shadow on the corrector (either 090° or 270°) while one-half the error is slowly adjusted out of the compass reading. The boat will then be turned to either 000° or 180°, the corrector's rose rotated to match it, and the whole procedure repeated. Without touching the corrector, the boat should then be slowly rotated past the East and West compass readings to make sure the compass readings agree with the shadow readings on the corrector. If they still do not agree (difference should be small at N, E, S & W), the whole procedure must be repeated to further refine adjustments.

If compass and corrector readings do agree closely at N, E, S & W, similar comparisons should then be made every 15° around a full 360° so that the Deviation Card on the cover of this handbook can be filled in. Done carefully, this can result in the most accurate deviation reference card obtainable by any technique.

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(7) Azimuths of the sun

Just as celestial navigators who cruise well offshore do not think that Aqua Meter might forget them, the declination of the sun is so predictable that it can be used to very accurately compensate a compass . . . as long as exact time is known, and the vessel's latitude can be estimated with an accuracy of about 30 miles. Some 200 pages of tables and explanation contained in U.S. Government Printing Office "H.O. Pub. 260" cover this very thoroughly.

Determining deviation . . . The good news and the bad news

The good news is that it is surprisingly easy to determine Deviation, and to fill in the simple, extremely useful Compass Deviation Card that is on the back cover of this handbook.

The bad news is that it is only easy to determine Deviation IF you have a pelorus, transit with bubble levels, or a sun compass available. Otherwise you are faced with having to estimate bearings by sighting across your installed compass, and this may or may not be practical on your boat. The dozens of textbooks and handbooks we checked ignore this problem, and make the job easy to write about, but frustrating to accomplish.

With instruments available. Just follow the instructions on **pages 18 and 19 under (5) and (9).**

With no instruments available:

(a) Study your charts to see if you can find pairs of aids and landmarks that you can use as "ranges", as described on page 15. Only now, since most deviation at the Cardinal points has already been removed by adjustment of the compensators, you are particularly interested in "ranges" with magnetic bearings near the Inter-Cardinal compass points of 045°, 135°, 225° and 315 degrees. From your chart, you may know that a "range" has a bearing of 040°, but your compass reads 044° when your bow is lined up on the range.

On the Compass Deviation Card (back cover) mark the magnetic bearing (from your chart) on the OUTER ROSE, and your actual compass reading on the INNER ROSE. Draw a line between the two. In the future, when a charted course is 040°, you can quickly see from the Deviation Card that you need to steer 044°. Of course it isn't practical to do this every 15°, because you aren't likely to find convenient ranges. However, when using a properly compensated compass you can expect greatest Deviation at the Inter-Cardinal points. If you find that Deviation is only three or possibly four degrees at these points, and you only cruise relatively short distances, you may want to estimate or even ignore Deviation when steering closer to N, E, S or W.

(b) If your compass is mounted so that you can accurately sight across it to take bearings at different angles (in addition to straight over your bow), you can build a more complete Deviation Card without instruments.

Just remember one essential point. You can take bearings at any angle around your boat to determine Deviation . . . but the Deviation you are calculating is **always** for the direction straight ahead of your bow. The following example should make this clear:

The chart showed our skipper a "range" (as described on page 16) convenient for compass compensating. Plotting showed that it bears 005° Magnetic. This means that a vessel heading directly toward the range, keeping one aid directly behind the other, is steering exactly 005° Magnetic.

Fig. A

Let's assume our skipper already used this range to compensate the compass, and as shown in Fig. A the compass reading is exactly 005°, and there is no Deviation at that heading.

Fig. B

Next, the boat was turned (Fig. B) and lined up so an observer could sight across the compass to read the bearing to the range, and also the boat's heading as shown on the compass. This bearing to the range happened to be 003°, and the boat's heading on the compass was 008°. Clearly, the bearing range was still actually 005° Magnetic, so there is an error in the compass bearing and that error is 005° – 003° = 2° of Deviation. Therefore although the boat's **compass** heading was 008°, the **magnetic** heading (used for plotting or chart reading) was 008° + 2° = 010° Magnetic. This line was drawn on the Deviation Card for future quick reference.

The boat was then turned further (Fig. C) and again lined up so the observer could sight across the compass and read the bearing to the range, as well as the boat's heading as shown on the compass. This time

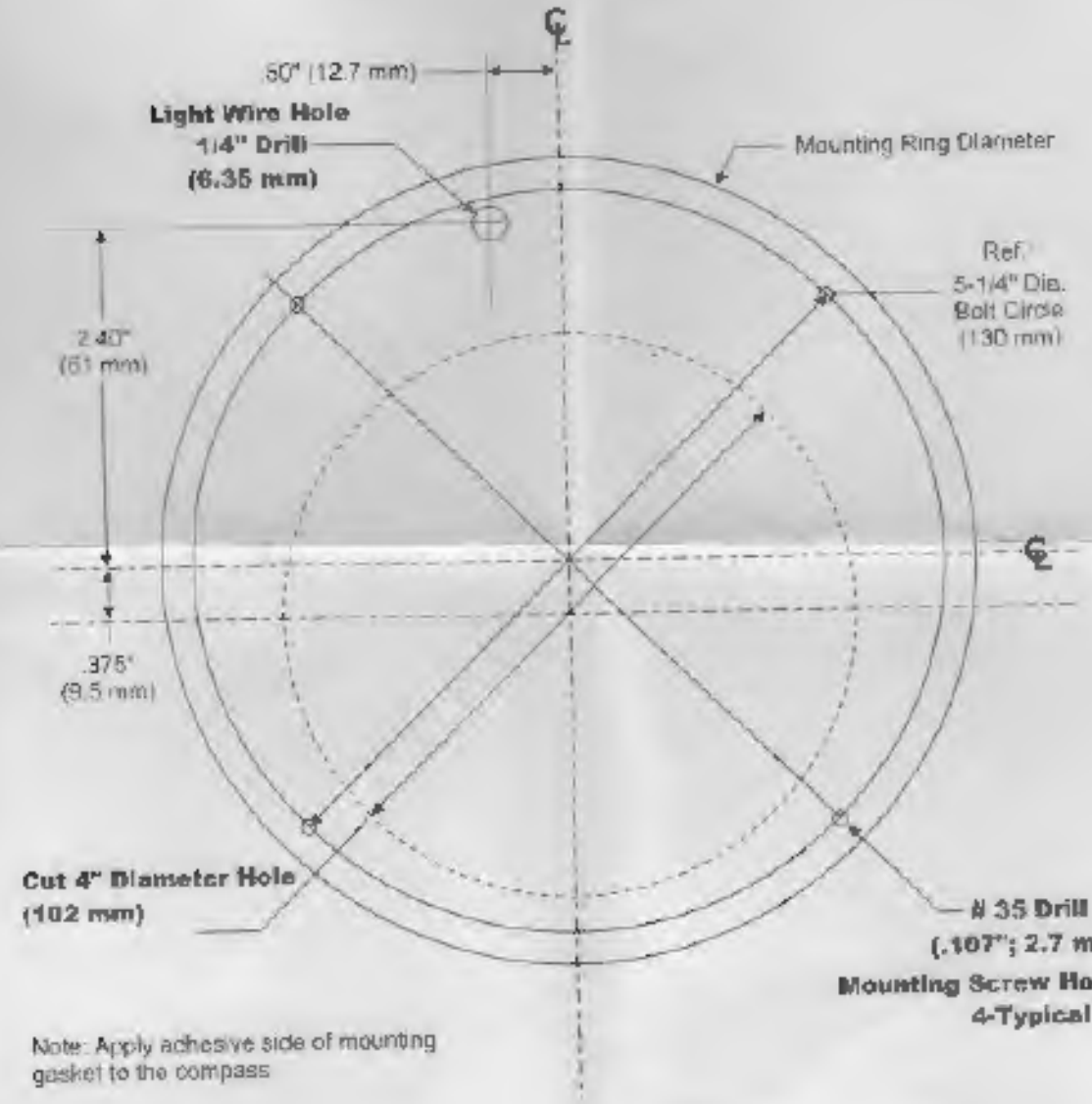
Fig. C

the compass bearing to the range was 012° and the compass heading was 007°. Since the magnetic bearing to the range could not have changed from 005° Magnetic, the Deviation of the boat heading was 012° – 005° = 7°. The boat's heading by compass of 007°, minus 7° of Deviation gives a corrected boat heading of 000° Magnetic. This also was drawn on the Deviation Card for future reference.

The same technique should be followed as far around the boat as possible, with readings approximately every 15° to 30° . . . always remembering that the Deviation calculated is for the boat's heading. Of course this will not give the Deviation for every possible compass heading, but it will make it possible for the skipper to estimate closely.

We have avoided explaining how to convert compass readings using TRUE, VARIATION, MAGNETIC, DEVIATION, AND COMPASS, because this technique can be taught more successfully in basic boating courses. We do strongly recommend that each teenager and adult who participates in boating take a United States Power Squadrons or U.S. Coast Guard Auxiliary (or other) basic course for increased safety and enjoyment.

A140 MOUNTING TEMPLATE



Note: Apply adhesive side of mounting gasket to the compass

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140-16
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